SEACAM: A Multipurpose Imaging and Ranging Camera For Low-Visibility MCM Missions

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LONG-TERM GOAL

The long-term goal of the SEACAM project is to provide Navy divers, and potentially mammal systems and UUV systems, with an underwater digital camera qualified for use in MCM missions. The camera will also have several mission specific functions, such as range-finding in order to properly scale the images, and low-visibility illumination in order to avoid observation by hostile forces.

OBJECTIVES

The specific objectives of this program are to design, fabricate, and test an underwater digital camera with a built in range-finder and low-visibility illumination. In addition, embedded software for controlling the camera and PC-level software for post-mission work with the resultant images are to be developed and tested. The system is to be packaged into a mechanical form that is ergonomically acceptable to the Navy divers.

APPROACH

Phase 1. Arete will create a functional prototype of the camera by making maximum use of existing hardware and COTS components. Once SEACAM is working in the lab, a water-resistant container will be designed to hold the individual parts. While functional, this version of SEACAM will not be in the final form to be used by the VSW detachment. A parallel activity in Phase 1 will be to design the final SEACAM mechanical package and build a non-functioning version of the camera for the purpose of testing the camera's handling and ergonomics. Arete will also provide software for performing post-mission analysis of the images (e.g., image display, target classification, target mapping, etc.).

Arete's diver team will perform ocean tests with the functional form of SEACAM to verify it meets its requirements under different water clarity and ambient lighting situations. Once it has been verified that the camera is functioning properly, it will be turned over to the VSW Detachment for test and evaluation (T&E). The non-functioning mock-up will also be turned over to the Detachment for T&E of the form factor in the VSW environment. The comments/desires of the VSW Detachment will then be used to modify the designs (both functional and form factor) for final integration in Phase 2.

Phase 2. Arete will perform the design and fabrication work necessary to integrate the desired SEACAM functions into the final form factor. Input from the VSW Detachment will be used to guide

this phase of the development. Two cameras will be manufactured for delivery to the VSW Detachment at this stage. Also, any desired changes in the post-mission analysis software will be provided at this time.

WORK COMPLETED

The Phase I camera was completed and assembled. Ocean tests with Arete personnel and with Navy divers have been conducted.

Figure 1 shows the mechanical package for the functional camera. The functional camera has several electronics boards that were developed independently in Phase I. There will be some consolidation of the boards in Phase II. Figure 2 shows the as-built functional camera with a flash assembly used during testing. The ergonomic camera (Figure 3) illustrates how the flash will be built into the base of the handle (Figure 3).

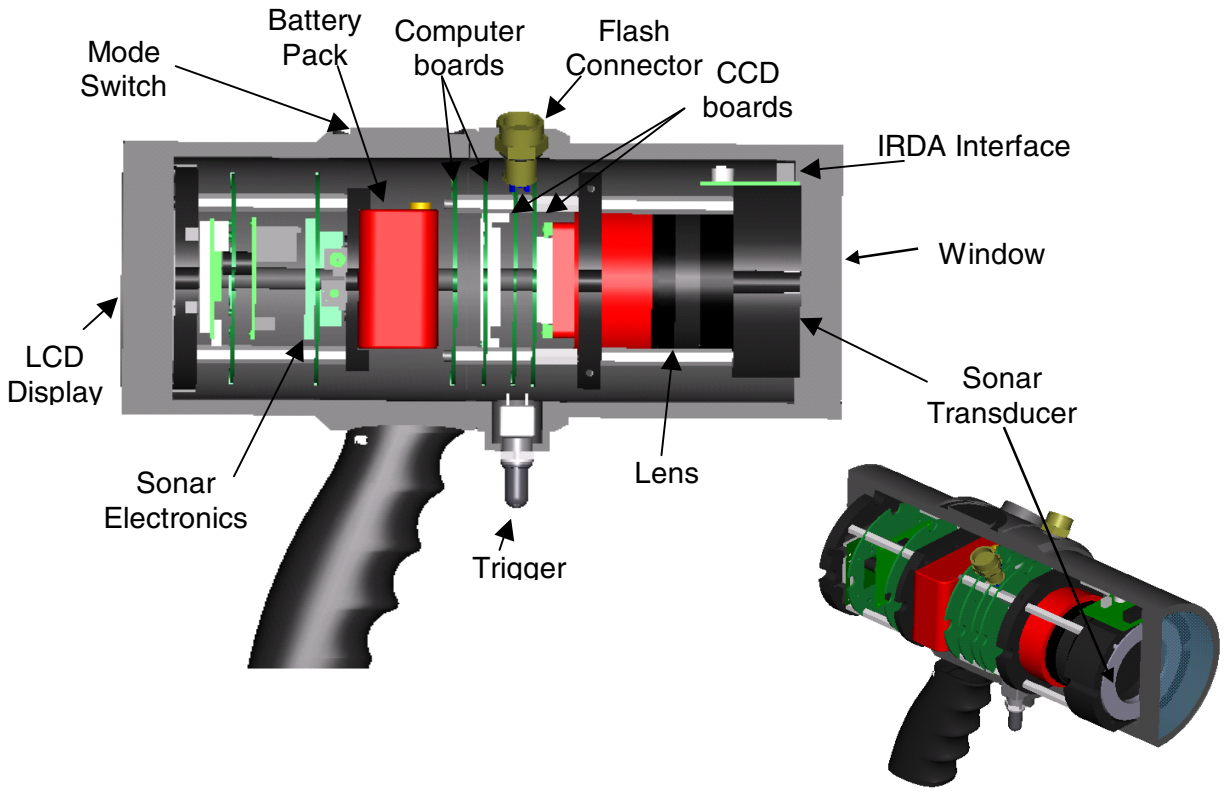
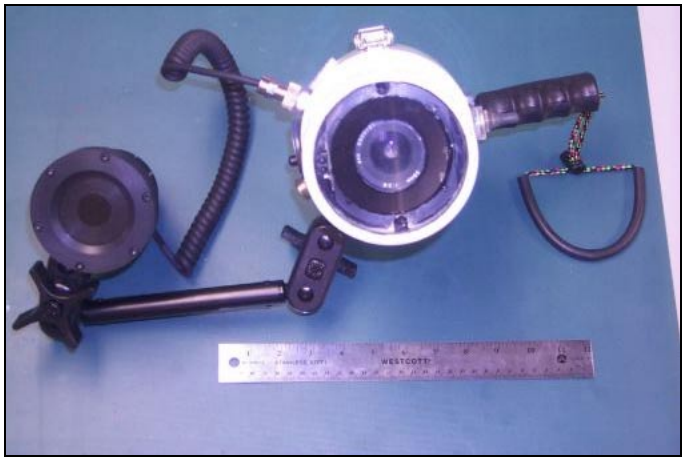


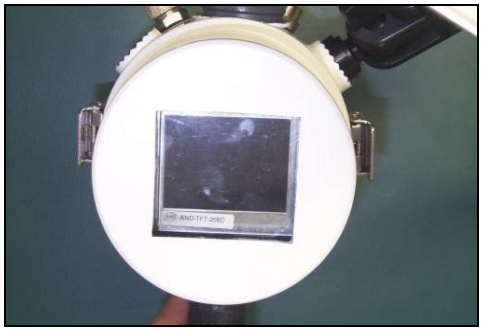
Figure 1. Mechanical Package for Phase I Functional Camera.

A sonar ranging system is used for SEACAM. The sonar system sends out a 330 KHz pulse for 300 microseconds, and has a field of view of ~6 degrees. The range resolution is 4" and the system operates from 1' to 30' ranges.

(a)



(b)



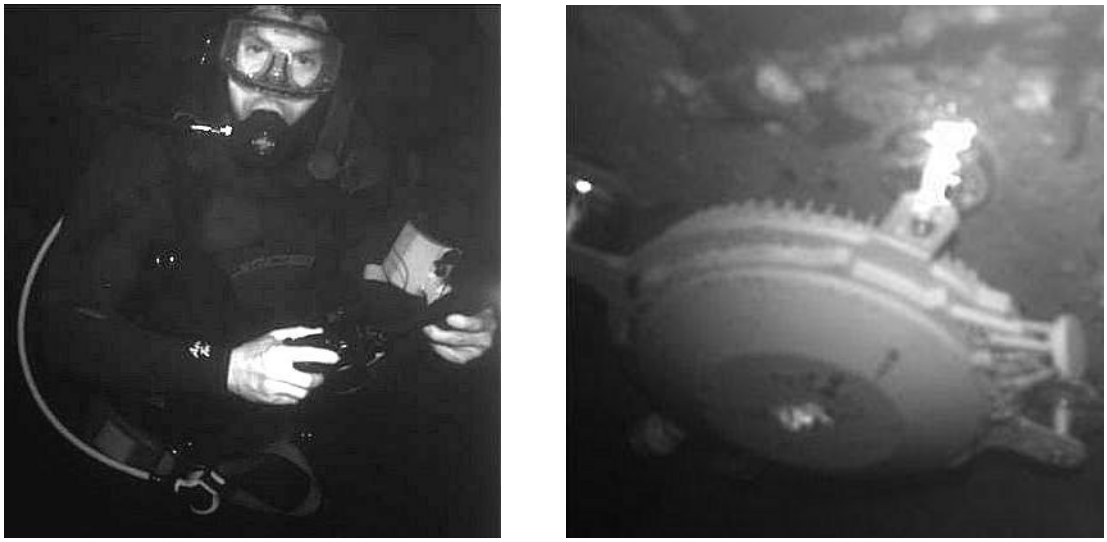
(c)

Figure 2. Photograph of Phase I Functional Camera with Flash Attachment. (a) Side view. (b) Front View Showing Lens, Transducer, and Flash. (c) Rear view of LCD Screen.

RESULTS

In general the imaging performance of the camera achieved it goals, but the sonar range-finder had technical issues. Figure 3 shows two images taken with the camera. The mine image was taken by Navy Divers while the diver image was taken by Arete personnel during field tests.

The sonar system worked well in the laboratory and intermittently in pool testing, which was expected because of the hard, smooth surfaces. However, in the ocean, the sonar system did not function. Tests of the sonar board, independent of the camera, have demonstrated good functionality, and subsequent investigation has shown some noise is introduced into the sonar system when the camera system is assembled. Work is continuing on providing both shielding and immunity to these noise surfaces.



(a) *(b)*

Figure 3. Seacam Images. (a) Diver. (b) Small Underwater Mine.

IMPACT/APPLICATION

SEACAM provides an opportunity for the VSW MCM community to develop a valuable component for MCM activities that can be used by divers, mammals, and UUVs in a wide variety of near- and far-term MCM missions. The potential utility of SEACAM, as a function of the programmatic timing, is given below.

Near Term. SEACAM will provide the divers with a number of capabilities: intelligence gathering, limited night vision, and ranging for countermining.

Mid Term. The integration of SEACAM with the other diver hardware, particularly the sonar and navigation systems (INSS), should be a very straightforward task. A large part of the camera volume will be the LCD display, the battery compartment, and the diver grips and input devices. By integrating SEACAM with the sonar hardware, a great deal of functionality can be combined into one device without adding significant volume or weight. This will have the additional benefit of allowing SEACAM direct access to the localization data in the navigation unit; therefore, the data can be automatically placed into the image file with no diver interaction.

Far Term. As UUVs become more prevalent, SEACAM can be provided at low cost as the "eyes" of such systems. For example, if a "crawler" type UUV were being used to place a countermine, SEACAM could be used to: (1) Help verify that the UUV was at the target; (2) determine the range to the target for countermine placement; and (3) provide an image of the target with the countermine explosives nearby for verification of delivery. Also, SEACAM can be used to enhance the capabilities of the mammal systems in that the camera can take pictures of targets found by the mammals, which will remove the requirement for the diver to visit as many targets in the countermining stage of the operation.

TRANSITIONS

Early in the program personnel from Arete met with divers (VSW MCM Test Detachment) in San Diego. During this meeting they obtained good input on ergonomics and materials, and also met with mammal systems engineers and discussed a future SEACAM version for the mammals. These meetings, early in the design stage of the program, ensure a smoother transition to field use of the hardware. Periodic meetings and testing opportunities with the divers throughout the program will ensure that Navy needs are being met.

RELATED PROJECTS

Arete Associates has an on-going and significant internal effort to develop the computer technology that is used in Seacam. This project is mainly for the development of fingerprint sensors, but SEACAM is taking full advantage of hardware and software improvements in the computer area.

PUBLICATIONS

Gleckler, A. and G. Fetzer, 1999. Multipurpose underwater imaging and ranging camera for low-visibility mine countermeasure (MCM) missions, *SPIE Proceedings*, Vol. 3711, pp. 141-150.

Gleckler, A. and A. Pittner, 2000. Multipurpose underwater imaging and ranging camera: Prototype system performance, *SPIE Proceedings*, April.